Electricity Consumption and Economic Growth Causality Revisited: Evidence from Turkey

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Abstract: The study reconsiders the relationship between electricity consumption and economic growth by incorporating financial development, capital and labor as important factors of production using augmented production function in Turkey for the period of 1971-2009. In doing so, we applied ARDL bounds testing approach and found long run relationship between electricity consumption, economic growth, financial development, capital and labour. Further, results indicated that electricity consumption, financial development, capital and labor have positive effect on economic growth. The VECM granger causality analysis shows bidirectional causality between electricity consumption, economic growth, financial development, capital and labor. The findings have important policy implication to sustain economic growth through comprehensive energy policy and developing financial sector in Turkey.

Keywords: Electricity consumption; Financial development; Economic growth
JEL Classification: C32; Q43

1. Introduction

Since 2001, Turkey's electricity demand has grown more than 8 percent annually. This high demand for electricity in Turkey is due to the technical, social and economic development. Thus, without serious mitigation measures, Turkey could experience supply shortfalls in the near term (ESMAP Report, 2009).

Electricity consumption and economic growth relationship is widely investigated topic since 1978 with the work of Kraft and Kraft (1978). The empirical literature for electricity consumption and economic growth relationship is analyzed in detail in the studies of Ozturk (2010) and Payne (2010). According to the literature survey, the direction of causality between electricity consumption and economic growth remains controversial. The literature that investigates the causal relationship between electricity consumption and economic growth yields mixed results in terms of the four hypotheses: (1) G*rowth hypothesis:* It infers that causality is running from electricity consumption to economic growth. (2) C*onservation hypothesis:* It is also called unidirectional causality running from economic growth to electricity consumption. (3) *Feedback hypothesis:* It implies that there is bidirectional causality between electricity consumption and economic growth. (4) N*eutrality hypothesis*: It is supported by the absence of a causal relationship between electricity consumption and economic growth. It is important to examine whether there is a causal relationship between electricity consumption and economic growth and the way of causality. This is because the direction of causality has significant policy implications for designing and implementing energy policies.

The main problem with the previous studies mentioned in Table-1 below is that they did not pay attention to put other potential variables into model to examine the electricity consumption-economic growth nexus. In other words, they employed bivariate models which cause an omitted variable problem. So, to avoid this problem, we used a multivariate model in this study by adding financial development, capital and labor variables into model using time series data over the period of 1971-2009 for Turkey. Therefore, this paper may be considered as a complementary study to the previous studies.

According to the empirical results of previous studies for Turkey summarized in Table-1, it can be seen that the causality runs from electricity consumption to economic growth in most cases.

Table-1: Empirical studies on electricity consumption–growth nexus for Turkey

Authors	Period	Variables	Methodology	Conclusion
Murry and Nan (1996)	1950-1970	Electricity consumption, GDP	Granger causality, VAR	$ELC \rightarrow GDP$
Altinay and Karagol (2005)	1950-2000	Electricity consumption, GDP	Granger-causality, Dolado–Lutkepohl causality	$ELC \rightarrow GDP$
Halicioglu (2007)	1968-2005	Residential electricity consumption, GDP, residential electricity price, the urbanization rate	Granger causality, ARDL cointegration	$GDP \rightarrow ELC$
Narayan and Prasad (2008)	1960-2002	Electricity consumption, GDP	Bootstrapped Granger-causality	$ELC \neq GDP$
Soytas and Sari (2007)	1968-2002	Industry electricity consumption, value added-Manufacturing, Manufacturing employment, manufacturing real fixed investment	Granger-causality, Vector error correction model, Johansen–Juselius cointegration	$IELC \rightarrow MVA$
Acaravci (2010)	1968-2005	Electricity consumption, GDP	Granger-causality	$ELC \rightarrow GDP$
Acaravci and Ozturk (2012)	1968-2006	Electricity consumption, GDP, employment	ARDL, Granger-causality	$ELC \rightarrow GDP$

Notes: $\rightarrow$, $\neq$, ELC, GDP, IELC, MVA represent unidirectional causality, no causality, electricity consumption, real gross domestic product, industrial electricity consumption, manufacturing value added respectively.

The aim of this study is to investigate the causal relationship between electricity consumption and economic growth in Turkey by using ARDL bounds testing approach of cointegration and VECM granger causality analysis for Turkey over the period of 1971–2009. The rest of the paper is organized as follows: section-2 presents the model and data description. Section-3 three reports the empirical results. The final section concludes the paper.

2. Model and Data

We use Cobb-Douglas production function by assuming marginal contribution of energy, capital and labor in production, production function in period *t* is given below:

$$Y(t) = A(t)K(t)^{\beta} L(t)^{1-\beta} \qquad 0 < \beta < 1 \tag{1}$$

Where Y is domestic output, A is technological progress, K is capital and labor is L in time period t. We extend the Cobb-Douglas production function by assuming that technology can be determined by level of financial development. Financial development contributes to economic growth by enhancing capitalization in an economy. This shows that financial development transfers the incentives of producers towards the goods with increasing returns to scale, the intersectoral specialization and therefore structure of trade flows, is determined by relative level of financial intermediation[1].

This leads us to model the empirical equation as following:

$$Y(t) = \phi.E(t)^{\delta_1} F(t)^{\delta_2} K(t)^{\beta} L(t)^{1-\beta} \tag{2}$$

Dividing both sides by population and taking logs, equation-2 can be modeled as following:

$$\ln Y_t = \varphi_1 + \varphi_2 \ln E_t + \varphi_3 \ln F_t + \varphi_4 \ln K_t + \varphi_5 \ln L_t + u_i \tag{3}$$

Where, $\varphi_1 = \log \phi$ is constant term, $\ln Y_t$ is log of real GDP per capita, $\ln E_t$ is log of electricity consumption per capita, $\ln F_t$ is real domestic credit to private sector per capita, $\ln K_t$ is real capital stock per capita, $\ln L_t$ is labor force participation and u_i is error term assumed to be constant.

To examine long run relationship between the variables over the period of 1971-2009, we have applied the autoregressive distributed lag model developed by Pesaran et al. (2001) which is also known as ARDL bounds testing approach to cointegration. The autoregressive distributive lag modeling is preferred over conventional cointegration techniques due to its due advantages. For instance, ARDL is appropriate once order of integration of the variable is uncertain i.e. I(1) or I(0) or I(1)/I(0) but no variable is stationary at I(2) or beyond that order. The ARDL bounds

[1] Goldsmith, 1969; King and Levine, 1993; Rajan and Zingales, 1998, 2003; Wurgler, 2000 and many others

testing approach is suitable for small samples and provides consistent results. Moreover, a dynamic unrestricted error correction model can also be derived from the ARDL bounds testing through a simple linear transformation. The autoregressive distributive lag modeling assimilates long run and short run dynamics without losing information about long run relationship. The UECM is expressed as follows:

$$\begin{aligned}\Delta \ln Y_t = {} & \vartheta_1 + \vartheta_T T + \vartheta_Y \ln Y_{t-1} + \vartheta_G \ln E_{t-1} + \vartheta_F \ln F_{t-1} + \vartheta_K \ln K_{t-1} + \vartheta_L \ln L_{t-1} + \sum_{i=1}^{p} \vartheta_i \Delta \ln Y_{t-i} \\ & + \sum_{j=0}^{q} \vartheta_j \Delta \ln E_{t-j} + \sum_{k=0}^{r} \vartheta_k \Delta \ln F_{t-k} + \sum_{l=0}^{s} \vartheta_l \Delta \ln K_{t-l} + \sum_{m=0}^{t} \vartheta_m \Delta \ln L_{t-m} + \mu_t\end{aligned} \tag{4}$$

$$\begin{aligned}\Delta \ln E_t = {} & \alpha_1 + \alpha_T T + \alpha_Y \ln Y_{t-1} + \alpha_E \ln E_{t-1} + \alpha_F \ln F_{t-1} + \alpha_K \ln K_{t-1} + \alpha_L \ln L_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta \ln E_{t-i} \\ & + \sum_{j=0}^{q} \alpha_j \Delta \ln Y_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta \ln F_{t-k} + \sum_{l=0}^{s} \alpha_l \Delta \ln K_{t-l} + \sum_{m=0}^{t} \alpha_m \Delta \ln L_{t-m} + \mu_t\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta \ln F_t = {} & \beta_1 + \beta_T T + \beta_Y \ln Y_{t-1} + \beta_E \ln E_{t-1} + \beta_F \ln F_{t-1} + \beta_K \ln K_{t-1} + \beta_L \ln L_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \ln F_{t-i} \\ & + \sum_{j=0}^{q} \beta_j \Delta \ln Y_{t-j} + \sum_{k=0}^{r} \beta_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \beta_l \Delta \ln K_{t-l} + \sum_{m=0}^{t} \beta_m \Delta \ln L_{t-m} + \mu_t\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta \ln K_t = {} & \rho_1 + \rho_T T + \rho_Y \ln Y_{t-1} + \rho_E \ln F_{t-1} + \rho_F \ln F_{t-1} + \rho_K \ln K_{t-1} + \rho_L \ln L_{t-1} + \sum_{i=1}^{p} \rho_i \Delta \ln K_{t-i} \\ & + \sum_{j=0}^{q} \rho_j \Delta \ln Y_{t-j} + \sum_{k=0}^{r} \rho_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \rho_l \Delta \ln F_{t-l} + \sum_{m=0}^{t} \rho_m \Delta \ln L_{t-m} + \mu_t\end{aligned} \tag{6}$$

$$\begin{aligned}\Delta \ln L_t = {} & \sigma_1 + \sigma_T T + \sigma_Y \ln Y_{t-1} + \sigma_E \ln E_{t-1} + \sigma_F \ln F_{t-1} + \sigma_K \ln K_{t-1} + \sigma_L \ln L_{t-1} + \sum_{i=1}^{p} \sigma_i \Delta \ln L_{t-i} \\ & + \sum_{j=0}^{q} \sigma_j \Delta \ln Y_{t-j} + \sum_{k=0}^{r} \sigma_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \sigma_l \Delta \ln F_{t-l} + \sum_{m=0}^{t} \sigma_m \Delta \ln K_{t-m} + \mu_t\end{aligned} \tag{7}$$

The 1st difference operator is shown by Δ and μ_t is for residual terms. The appropriate lag length of the first differenced regression is chosen on the basis of minimum value of akaike information criteria (AIC). The F-statistic is sensitive with lag order selection. The inappropriate lag length selection may provide misleading results. Pesaran et al. (2001) developed an F-test to determine the joint significance of the coefficients of lagged level of the variables. For example, the hypothesis of no cointegration between the variables in equation (3) is $H_0 : \vartheta_Y = \vartheta_E = \vartheta_D = \vartheta_K = \vartheta_L = 0$ while hypothesis of cointegration is $H_0 : \vartheta_Y \neq \vartheta_E \neq \vartheta_D \neq \vartheta_K \neq \vartheta_L \neq 0$. Pesaran et al. (2001) generated two asymptotic critical values i.e. upper critical bound (UCB) and lower critical bound (LCB), are used to take decisions whether cointegration exists or not between the series. The lower critical bound is used to test cointegration if all the series are integrated at I(0) otherwise we use upper critical bound (UCB). Our computed F-statistics are $F_Y(Y/E,F,K,L)$, $F_E(E/Y,F,K,L)$, $F_F(F/Y,E,K,L)$, $F_K(K/Y,E,F,L)$ and $F_L(L/Y,E,F,K)$ for equations (4) to (7) respectively. The long run relationship between the variables exists if our calculated F-statistic is greater than upper critical bound (UCB). There is no cointegration between the series, if our calculated F-statistic does not exceed lower critical bound (LCB). Our decision regarding cointegration is inconclusive if calculated F-statistic falls between LCB and UCB. In such an environment, error correction method is an easy and suitable way to investigate cointegration between the variables.

We have used critical bounds generated by Narayan (2005) to test cointegration rather than Pesaran et al. (2001). The critical bounds generated by Pesaran et al. (2001) are suitable for large sample size (T = 500 to T = 40, 000). It is pointed out by Narayan and Narayan (2005) that the critical values computed by Pesaran et al. (2001) may provide biased decision regarding cointegration between the series. The reason is that the critical bounds by Pesaran et al. (2001) are significantly downwards (Narayan and Narayan, 2005). The upper and lower critical bounds computed by Narayan (2005) are more appropriate for small samples ranges from T = 30 to T = 80.

Once cointegration is confirmed between the series, the next turn is to test the direction of causal relationship between electricity consumption, financial development, economic growth, capital and labor using augmented production function. It is suggested by Granger (1969) that we should apply vector error correction method (VECM) to detect causal relation between the variables if the series are found to be stationary at unique order of integration. Comparatively, the VECM is restricted form of unrestricted VAR (vector autoregressive) and restriction is levied on the presence of long run relationship between the series. All the series are endogenously used in the system of error correction model (ECM). This shows that in such an environment, response variable is explained both by its own lags and lags of independent variables as well as the error correction term and by residual term. The VECM in five variables case can be written as follows:

$$\Delta \ln G = \alpha_{\circ 1} + \sum_{i=1}^{l} \alpha_{11} \Delta \ln G_{t-i} + \sum_{j=1}^{m} \alpha_{22} \Delta \ln E_{t-j} + \sum_{k=1}^{n} \alpha_{33} \Delta \ln F_{t-k} + \sum_{r=1}^{o} \alpha_{44} \Delta \ln K_{t-r} + \sum_{s=1}^{p} \alpha_{55} \Delta \ln L_{t-s} + \eta_1 ECT_{t-1} + \mu_{1i} \quad (8)$$

$$\Delta \ln E = \beta_{\circ 1} + \sum_{i=1}^{l} \beta_{11} \Delta \ln E_{t-i} + \sum_{j=1}^{m} \beta_{22} \Delta \ln G_{t-j} + \sum_{k=1}^{n} \beta_{33} \Delta \ln F_{t-k} + \sum_{r=1}^{o} \beta_{44} \Delta \ln K_{t-r} + \sum_{s=1}^{p} \beta_{55} \Delta \ln K_{t-s} + \eta_2 ECT_{t-1} + \mu_{2i} \quad (9)$$

$$\Delta \ln F = \phi_{\circ 1} + \sum_{i=1}^{l} \phi_{11} \Delta \ln F_{t-i} + \sum_{j=1}^{m} \phi_{22} \Delta \ln E_{t-j} + \sum_{k=1}^{n} \phi_{33} \Delta \ln G_{t-k} + \sum_{r=1}^{o} \phi_{44} \Delta \ln K_{t-r} + \sum_{s=1}^{P} \phi_{55} \Delta \ln L_{t-s} + \eta_3 ECT_{t-1} + \mu_{3i} \quad (10)$$

$$\Delta \ln K = \varphi_{\circ 1} + \sum_{i=1}^{l} \varphi_{11} \Delta \ln K_{t-i} + \sum_{j=1}^{m} \varphi_{22} \Delta \ln G_{t-j} + \sum_{k=1}^{n} \varphi_{33} \Delta \ln E_{t-k} + \sum_{r=1}^{o} \varphi_{44} \Delta \ln F_{t-r} + \sum_{s=1}^{p} \varphi_{55} \Delta \ln L_{t-s} + \eta_4 ECT_{t-1} + \mu_{4i} \quad (11)$$

$$\Delta \ln L = \delta_{\circ 1} + \sum_{i=1}^{l} \delta_{11} \Delta \ln L_{t-i} + \sum_{j=1}^{m} \delta_{22} \Delta \ln G_{t-j} + \sum_{k=1}^{n} \delta_{33} \Delta \ln E_{t-k} + \sum_{r=1}^{o} \delta_{44} \Delta \ln F_{t-r} + \sum_{s=1}^{p} \delta_{55} \Delta \ln K_{t-s} + \eta_4 ECT_{t-1} + \mu_{4i} \quad (12)$$

Where u_{it} are residual terms and assumed to be identically, independently and normally distributed. The statistical significance of lagged error term i.e. ECT_{t-1} further validates the established long run relationship between the variables. The estimates of ECT_{t-1} also show the speed of convergence from short run towards long run equilibrium path in all models. The VECM is superior to test the causal relation once series are cointegrated and causality must be found at least from one direction. Further, VECM helps to distinguish between short-and-long run causal relationships. The VECM is also used to detect causality in long run, short run and joint i.e. short-and-long runs respectively in the following three possible ways: The statistical significance of estimate of lagged error term i.e. ECT_{t-1} with negative sign confirms the existence of long run causal relation using the t-statistic. Short run causality is indicated by the joint χ^2 statistical significance of the estimates of first difference lagged independent variables. For example, the significance of $\alpha_{22,i} \neq 0 \forall_i$ implies that electricity consumption Granger-causes economic growth and causality runs from economic growth to electricity consumption can be inferred by the significance of $\beta_{22,i} \neq 0 \forall_i$. The same inference can be drawn for rest of causality hypotheses. Finally, we use Wald or F-test to test the joint significance of estimates of lagged terms of independent variables and error correction term. This further confirms the existence of short-and-long run causality relations (Shahbaz et al. 2011) and known as measure of strong Granger-causality (Oh and Lee, 2004).

The VECM granger approaches have failed to capture the relevant strength of causal effect of the variables beyond sample period (Wolde-Rufael, 2009). This approach also drags out the degree of the feedback from one variable to the other. To overcome this limitation of VECM Granger causality test, Shan, (2005) proposed new term, innovative accounting approach (IAA) which is combination of variance decomposition and impulse response function to check the direction of causality between the variables. Variance decomposition method (VDM) helps to determine the response of the dependent variable to shocks stemming from independent variables. The variance decomposition method is considered an alternative to impulse response function (IRF).

The data used in our paper is real GDP per capita, electricity consumption per capita (kg of oil equivalent per capita), per capita real domestic credit to private sector, capital use per capita and labour force. The world development indicators (WDI-CD, 2010) is combed to collect data for mentioned variables.

3. Empirical Results and Discussions

3.1. Unit Root Test Results

The long run relationship between the variables has been investigated by applying ARDL cointegration approach to cointegration. The main merit of ARDL bounds testing is that it can be used if the variables are integrated either at I(0) or I(1) or I(0)/I(1). So, to ensure this that no variable is stationary at I(2) or beyond this level, we have applied ADF unit root test by Dickey and Fuller (1979), DF-GLS unit root test by Elliot et al. (1996) and Ng-Perron unit root test by Ng and Perron (2001)**.** These unit root tests indicated that all the variables have unit root problem at their level form but found to be integrated at I(1)[2]. But, Baum (2004) pointed out that unit root analysis by ADF, DF-GLS and Ng-Perron unit root tests may provide biased results when structural break occurs in the series.

To resolve the issue, we used a structural break unit root test such as Clemente-Montanes-Reyes (1998) de-trended structural break unit root test that contains information about two structural break points in the series (Table 2)[3]. Clemente-Montanes-Reyes unit root test provides information about two possible structural break points in the series through (1) an additive outliers (AO) model that point out a sudden change in the mean of a series and (2) an innovational outliers (IO) model that indicates gradual shifts in the mean of the series. As a result, the additive outlier model is more appropriate for series having sudden structural changes as compared to gradual shifts.

[2] Results of these unit root tests are available from authors upon request.
[3] We ignored Zivot-Andrews (1996) structural break unit root test because it has information about one structural break occurred in the series.

Table-2: Clemente-Montanes-Reyes Detrended Structural Break Unit Root Test

Variable	Innovative Outliers				Additive Outlier			
	t-statistic	TB1	TB2	Decision	t-statistic	TB1	TB2	Decision
$\ln Y_t$	-2.833 (6)	1984	2002	I(0)	-6.633 (2)*	1979	2000	I(1)
$\ln E_t$	-3.712 (3)	1982	2001	I(0)	-6.169 (3)*	1976	2000	I(1)
$\ln F_t$	-0.872 (2)	1984	1993	I(0)	-7.130 (3)*	1996	2003	I(1)
$\ln K_t$	-4.994 (3)	1985	2002	I(0)	-6.825 (3)*	1986	2002	I(1)
$\ln L_t$	-4.311 (4)	1982	2003	I(0)	-14.928 (2)*	1981	1995	I(1)

Note: * indicates significant at 1% level of significance.

3.2. Cointegration Analysis

The unique order of integration of the variables supports us to investigate the long run relationship between the variables by applying ARDL bounds testing approach to cointegration. The data period of study is from 1971-2009 in case of Turkey. The appropriate lag length is prerequisite to continue the ARDL bounds testing to examine cointegration between the series. The AIC and SBC criterions are followed to chose lag length.

Table-3: The Results of ARDL Cointegration Test

<table>
<tr><td colspan="3">Bounds Testing to Cointegration</td><td colspan="4">Diagnostic tests</td></tr>
<tr><td>Estimated Models</td><td>Optimal lag length</td><td>F-statistics</td><td>χ^2_{NORMAL}</td><td>χ^2_{ARCH}</td><td>χ^2_{RESET}</td><td>χ^2_{SERIAL}</td></tr>
<tr><td>$F_Y(Y/E,F,K,L)$</td><td>2, 2, 1, 2, 2</td><td>13.220*</td><td>2.0173</td><td>[1]: 0.9002</td><td>[1]: 0.3661</td><td>[4]: 5.4214; [5]: 3.2182</td></tr>
<tr><td>$F_E(E/Y,F,K,L)$</td><td>2, 2, 2, 2, 2</td><td>7.495*</td><td>2.3490</td><td>[1]: 1.5033</td><td>[1]: 1.5328</td><td>[4]: 3.9510; [5]: 3.8011</td></tr>
<tr><td>$F_F(F/Y,E,K,L)$</td><td>3, 2, 2, 2, 1</td><td>4.925***</td><td>0.3343</td><td>[2]: 2.1071</td><td>[2]: 1.8007</td><td>[1]: 1.5610; [2]: 5.6425</td></tr>
<tr><td>$F_K(K/Y,E,F,L)$</td><td>2, 2, 2, 2, 2</td><td>6.598**</td><td>1.7295</td><td>[1]: 0.5015</td><td>[1]: 0.4553</td><td>[1]: 2.1079; [2]: 2.6240</td></tr>
<tr><td>$F_L(L/Y,E,F,K)$</td><td>3, 2, 2, 1, 1</td><td>15.404*</td><td>1.4048</td><td>[1]: 0.0102</td><td>[1]: 2.0927</td><td>[1]: 0.6843; [3]: 1.2867</td></tr>
<tr><td rowspan="2">Significant level</td><td>Critical values (T= 40)#</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Lower bounds $I(0)$</td><td>Upper bounds $I(1)$</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1 per cent level</td><td>6.053</td><td>7.458</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5 per cent level</td><td>4.450</td><td>5.560</td><td></td><td></td><td></td><td></td></tr>
<tr><td>10 per cent level</td><td>3.740</td><td>4.780</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Note: The asterisks * and ** denote the significant at 1, 5 and 10 per cent levels, respectively. The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. # Critical values are collected from Narayan (2005).</td></tr>
</table>

Our selection of lag length is based on the minimum value of AIC. Lütkepohl, (2006) pointed out that AIC lag length criteria provides efficient and reliable results to capture dynamic relation between the variables. So, using AIC criteria, lag order of the series is shown in Table-3. The results of ARDL bounds testing cointegration are also reported in Table-3.

We chose ARDL bounds testing approach to cointegration with intercept and trend to compute F-statistic following Shahbaz et al., (2011). The details have been explained by Narayan and Smyth (2006) if anyone desires to apply the bounds tests with or without time trend variable[4]. The results indicate that our calculated F-statistics are 13.22, 7.495, 4.925, 6.598 and 15.404 greater than upper critical bounds generated by Narayan (2005). The significance level is 1%, 5% and 10% respectively. The results report cointegration between the series when economic growth, electricity consumption, financial development, capital and labour are used as response variables. This implies that long run relationship between economic growth, electricity consumption, financial development, capital and labour is found over the period of 1971-2009 in case of Turkey.

The robustness of long run results is investigated by applying Johansen multivariate cointegration approach and Table-4 reports the empirical findings. The Trace test and maximum Eigen value confirm that there are two cointegrating vectors validating the cointegration between the variables. This shows that the long run results are consistent and robust.

Table-4: Results of Johansen Cointegration Test

Hypothesis	Trace Statistic	Maximum Eigen Value
$R = 0$	111.4499*	53.2014*
$R \leq 1$	58.2484*	38.2158*
$R \leq 2$	20.0325	12.1168
$R \leq 3$	7.9156	7.26725
$R \leq 4$	0.6484	0.6484
Note: * indicates significance at 1% level.		

[4] The results of bounds test without time trend variable are available from authors upon request.

After finding long run relationship between the variables, the marginal long run and short run results are pasted in Table-5. The results reported in Table-4 show that electricity consumption attributes economic growth at 1 percent level. Keeping other things constant, a 1 percent growth in electricity consumption boosts economic growth by 0.11 per cent. Financial development positively contributes to economic growth and it is statistically significant at 1 percent level. Financial development leads economic growth by promoting stock market development. A 1 percent rise in financial development raises economic growth by 0.16 percent, all else is same. The effect of capital is positive and statistically significant at 5 percent level of significance.

Table-5: Long-Run and Short-Run Analysis

Dependent Variable = $\ln Y_t$		
Long-Run Results		
Variable	Coefficient	T-Statistic
Constant	-0.4288	-0.4773
$\ln E_t$	0.1184	3.2845*
$\ln F_t$	0.1633	9.0790*
$\ln K_t$	0.0611	2.7099**
$\ln L_t$	0.1274	4.6745*
Short-Run Results		
Variable	Coefficient	T-Statistic
Constant	-0.0010	-0.1039
$\ln E_t$	0.1881	1.8672***
$\ln F_t$	0.1071	5.0872*
$\ln K_t$	0.1349	5.0243*
$\ln L_t$	0.0592	0.5189
ECM_{t-1}	-0.3417	-2.5857**
Diagnostic Tests		
Test	F-statistic	Prob. Value
$\chi^2 NORMAL$	0.6227	0.7324
$\chi^2 SERIAL$	1.9065	0.1667
$\chi^2 ARCH$	0.9077	0.3477
$\chi^2 WHITE$	0.2624	0.9843
$\chi^2 REMSAY$	2.0363	0.1639
Note: *, ** and ** denote the significant at 1%, 5% and 10% levels.		

This implies that a 0.06 percent economic growth is linked with a 1 percent rise in capital assuming other economic agents constant. The positive relation is found from labor to economic growth and it is statistically significant at 1 percent level. The role of labor is dominant after financial development in case of Turkey.

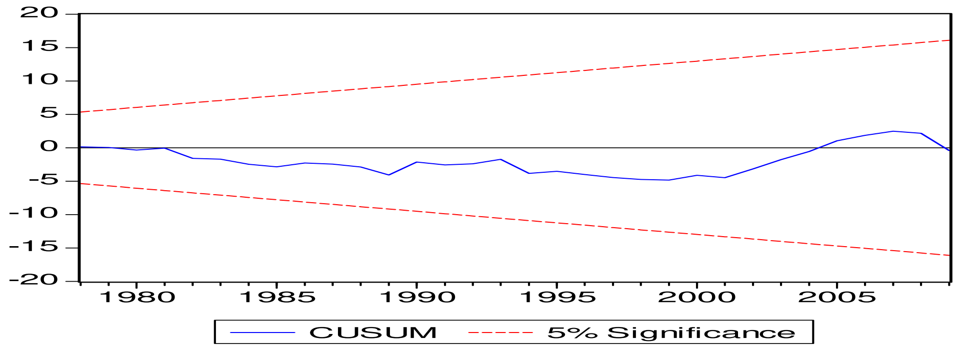
The lower segment of Table-5 shows the results of short run dynamics in case of Turkey. In short run, electricity consumption attributes economic growth at 10 percent level. The impact of financial development on economic growth is positive and it is statistically significant at 1 percent. The growth in capital also spurs economic growth at 1 percent level of significance. Finally the effect of labor force is positive but statistically it is insignificant.

The error correction term i.e. ECM_{t-1} between the cointegrated series indicates that a change in the predicted variable is a function of both the levels of disequilibrium in the cointegrating relationship and the changes in other explanatory variables such as electricity consumption, financial development, capital and labour. The significance of ECM_{t-1} provides the speed of adjustment from the short run towards the long run. Bannerjee et al. (1998) argued that a significant lagged error term with negative sign indicates the stable long run relationship. The estimated coefficient suggests that the energy demand is corrected by 65.16 percent annually from the short to the long runs equilibrium.

The short run model has passed all diagnostic tests successfully. The empirical exercise shows normality of error term. The residual term is not correlated with dependent or explanatory variables i.e. no serial correlation is found. The short run specification also passed the test of ARCH and suggesting autoregressive conditional homoscedasticity. The empirical evidence also points out that short run model is well specified confirmed by Ramsey Reset test and there is an evidence of homoscedasticity confirming the constancy of variance of error term.

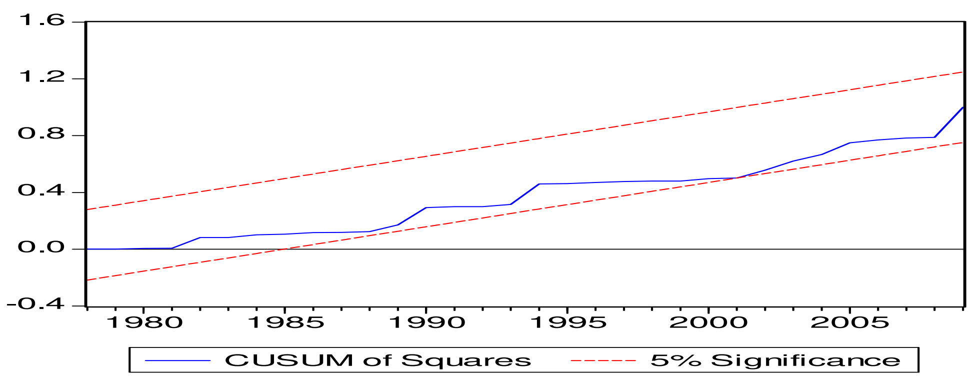
The cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) tests are used to examine the stability of the long and short run parameters. If the plots of the statistics for both the tests lie within the 5 percent critical bounds, one may accept the hypothesis that "the regression equation is correctly specified" (Bahmani-Oskooee and Nasir, 2004: p.485). Our results meet these guidelines as in Figures 1 and 2. Thus the model is stable and correctly specified.

Figure-1: Plot of Cumulative Sum of Recursive



Note: The straight lines represent critical bounds at 5% significance level.

Figure-2: Plot of Cumulative Sum of Squares of Recursive Residuals



Note: The straight lines represent critical bounds at 5% significance level.

3.3. VECM Granger Causality Analysis

The cointegration between electricity consumption, financial development, economic growth, capital and labor tends for long run relationship provides support to examine direction of causality applying Granger causality test. The exact direction of causal relation among electricity consumption, financial development and economic growth seems to help policy makers in formulating a comprehensive electricity production policy to situating economic growth by promoting financial development in the country for long run. The VECM Granger causality is suitable approach for causality analysis between electricity consumption, financial development, economic growth, capital and labor in short run as well as long run, once the series are stationary at I(1) and cointegration is confirmed between these series. The details of VECM Granger causality are reported in Table-6.

In long run, results show that feedback hypothesis is validated between electricity consumption, financial development, economic growth, capital and labour force in case of Turkey over the study period 1971-2009. The significance of ECT_{t-1} indicates the convergence rate is high in financial development (-0.5881), capital (-0.3176) and economic growth (-0.3166) as compared to electricity consumption (-0.2044) and labor (-0.0269) VECMs.

The findings of feedback effect found between electricity consumption and economic growth are contradictory with the line of Turkish energy literature such as Murry and Nan (1996), Altinay and Karagol (2005), Halicioglu (2007), Soytas and Sari (2007), Narayan and Prasad (2008), Acaravci (2010), and Acaravci and Ozturk (2012). The bidirectional causal relation between financial development and economic growth exists. In other words, financial development and energy consumption Granger cause each other. This is consistent with the findings by Shahbaz and Lean (2012) who found feedback hypothesis between the variables in case of Tunisia.

Table-6: VECM Granger Causality Analysis

Type of Granger Causality											
Dependent Variables	Short-run					Long-run	Joint (short- and long-run)				
	$\ln Y_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$	ECT_{t-1}	$\ln Y_t, ECT_{t-1}$	$\ln E_t, ECT_{t-1}$	$\ln F_t, ECT_{t-1}$	$\ln K_t, ECT_{t-1}$	$\ln L_t, ECT_{t-1}$
	F-statistics [p-values]					[T-statistics]	F-statistics [p-values]				
$\ln Y_t$	…	1.3245 [0.2847]	10.2636* [0.0005]	15.5060* [0.0000]	0.0433 [0.9573]	-0.3166** [-2.0508]	…	2.5178*** [0.0793]	7.8186* [0.0007]	12.0953* [0.0000]	2.0830 [0.1260]
$\ln E_t$	3.5107* [0.0345]	…	0.8438 [0.4415]	1.3098 [0.2871]	4.7130** [0.0179]	-0.2044** [-2.6690]	4.4321** [0.0121]	…	2.5601*** [0.0767]	2.7074*** [0.0612]	3.1902** [0.0402]
$\ln F_t$	4.5939** [0.0196]	0.3266 [0.7246]	…	0.8229 [0.4503]	0.0093 [0.9907]	-0.5881** [-2.5820]	3.3345** [0.0347]	3.0772** [0.0451]	…	2.2332*** [0.1080]	3.4778** [0.0311]
$\ln K_t$	12.3995* [0.0002]	0.6147 [0.5491]	1.2066 [0.3167]	…	3.9530** [0.0328]	-0.3176*** [-1.9013]	11.3520** [0.0001]	2.6694*** [0.0704]	7.1154* [0.0014]	…	3.3895** [0.0344]
$\ln L_t$	0.5079 [0.6081]	1.2270 [0.3109]	0.4492 [0.6433]	1.5417 [0.2345]	…	-0.0269** [-2.5398]	3.1662** [0.0369]	2.9031*** [0.0556]	2.2493*** [0.1080]	4.9095* [0.0084]	…

Note: *, ** and *** show significance at 1%, 5% and 10% levels respectively.

In short run, feedback hypothesis is validated between financial development and economic growth. The unidirectional causal relationship is found running from economic growth and labour to electricity consumption. The bidirectional causality is also found between capital and economic growth. Capital is being Granger caused by labour.

The main problem with Granger causality approaches such VECM Granger causality test is that it shows causal relationship between the variables within selected time period. In such situation, results by VECM Granger causality test are not helpful for policy makers for future. The VECM Granger causality test does say anything about the causality between the series beyond the selected sample period. This makes the VECM Granger causality analysis weak and unreliable. So to avoid this problem, innovative accounting approach is applied to examine exact causal link between electricity consumption, financial development, capital and labor and to test the robustness of VECM Granger causality results. The innovative accounting approach (IAA) is combination of variance decomposition method (VDM) and impulse response function (IRF). The VDM shows the response of the predicted variable due to shocks stemming in explanatory variables. The IRF is an alternate of VDM and figure-3 shows the graph of impulse response function.

The Table-7 presents the results of VDM. The variance decomposition approach indicates the magnitude of the predicted error variance for a series accounted for by innovations from each of the independent variable over different time-horizons beyond the selected time period. The innovative shocks stemming in electricity consumption, financial development, capital and labor explain economic growth by 18.64%, 17.40%, 12.39% and 1.97% respectively and rest i.e. 49.58% is explained by economic growth itself. The contribution of economic growth, financial development, capital and labour in electricity consumption is 28.48%, 21.34%, 11.28% and 2.08% respectively. The 36.80% portion in electricity consumption is contributed by its own innovative shocks. The results show bidirectional causality between electricity consumption and economic growth in case of Turkey.

Table-7: Variance Decomposition Method (VDM)

Variance Decomposition of $\ln Y_t$					
Period	$\ln Y_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	100.0000	0.0000	0.0000	0.0000	0.0000
2	76.0916	12.3989	8.7415	2.5594	0.2084
3	74.3319	12.4418	7.9914	4.6590	0.5758
4	72.7161	12.2378	7.2908	6.7640	0.9909
5	70.9182	12.1978	6.9591	8.5452	1.3795
6	69.2982	12.4766	6.7564	9.7631	1.7056
7	67.5755	12.9986	6.9862	10.4870	1.9525
8	65.3438	13.7193	7.9579	10.8651	2.1136
9	62.5967	14.5707	9.5837	11.0533	2.1955
10	59.6104	15.4816	11.5039	11.1902	2.2137
11	56.6845	16.3838	13.3721	11.3729	2.1865
12	54.0016	17.2271	14.9986	11.6423	2.1302
13	51.6326	17.9839	16.3337	11.9921	2.0574
14	49.5831	18.6454	17.4014	12.3924	1.9775
15	47.8318	19.2147	18.2472	12.8089	1.8970
Variance Decomposition of $\ln E_t$					
Period	$\ln Y_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	55.2595	44.7404	0.0000	0.0000	0.0000
2	53.4278	42.6895	2.0773	1.6701	0.1351
3	50.0838	43.2967	3.9519	2.2865	0.3809
4	49.0181	42.5617	4.7959	2.8988	0.7252
5	47.6007	42.0491	5.6173	3.6095	1.1232
6	45.8936	41.6122	6.5677	4.3971	1.5292
7	43.8618	41.2361	7.7961	5.2116	1.8942
8	41.6121	40.8371	9.3422	6.0263	2.1820
9	39.2593	40.3742	11.1657	6.8274	2.3731
10	36.9343	39.8357	13.1503	7.6127	2.4668
11	34.7496	39.2381	15.1521	8.3838	2.4762
12	32.7849	38.6099	17.0414	9.1413	2.4223
13	31.0820	37.9807	18.7283	9.8819	2.3269
14	29.6511	37.3738	20.1667	10.598	2.2094
15	28.4807	36.8055	21.3459	11.283	2.0845

The results in Table-8 note that financial development itself is explained 56.07% portion through its own innovative shocks. The contribution of economic growth, electricity consumption, capital and labor is 20.43%, 7.77%, 15.33% and 0.38% respectively. The contribution of economic growth and financial development to explain capital is significant as compared to labour. Economic growth and financial development promote capital by 42.25% and 25.06% while labor attributes capital negligibly i.e. 5.75%. A 13.40% portion of capital is contributed by its own innovative shocks. In labor section, capital is 13.27%, 32.20%, 35.73% and 13.56% contributed by economic growth, electricity consumption, financial development and capital respectively. Only, a 5.21% portion is attributed by its own innovative shocks and it is ignorable. Overall results indicate that the feedback effect is validated between electricity consumption and economic growth in case of Turkey. The results provided by IAA are slightly different from VECM Granger causality analysis. This may be due to the difference in methodological backgrounds (Shahbaz et al. 2012).

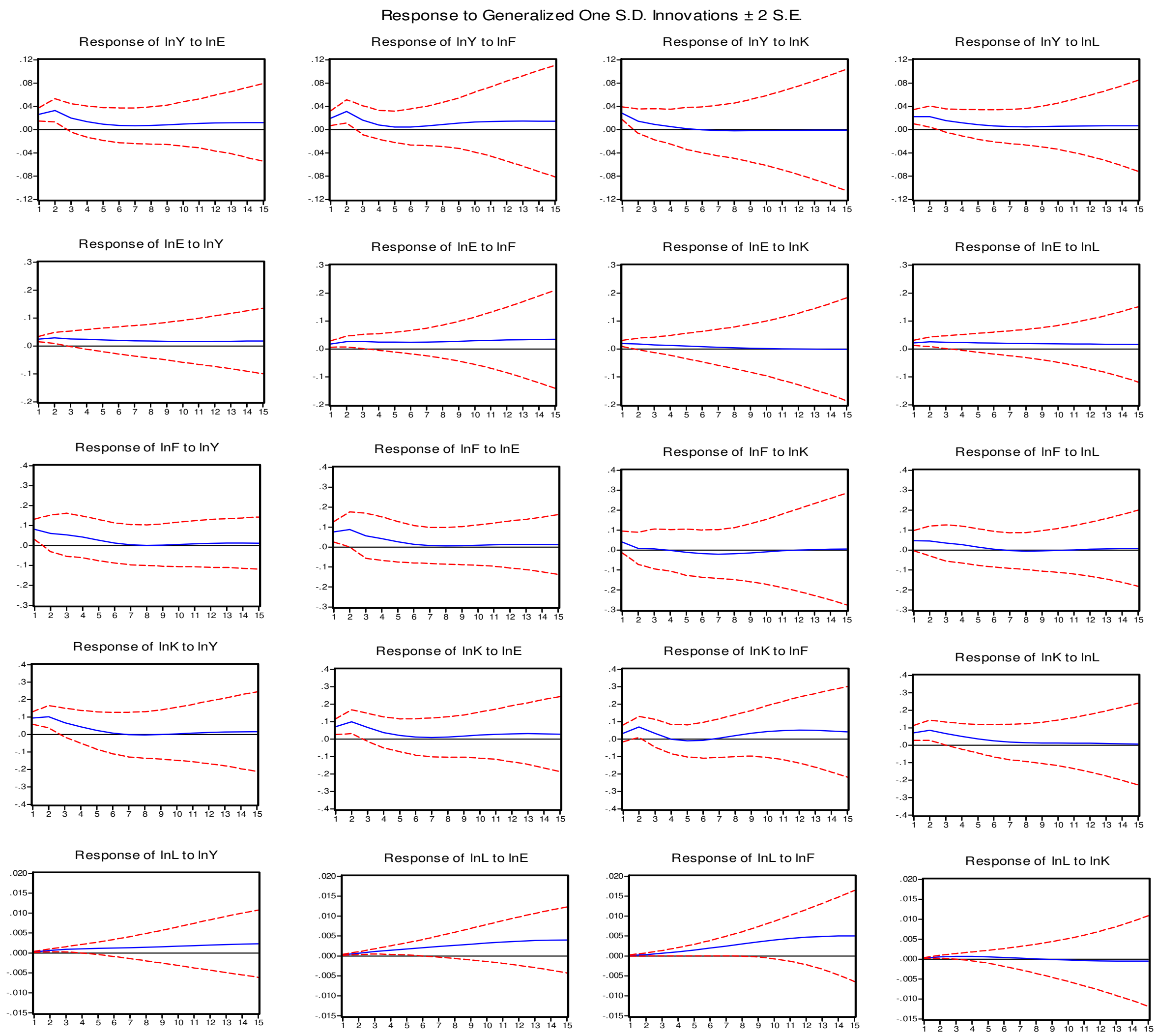
Table-8: Variance Decomposition Method (VDM)

Variance Decomposition of $\ln F_t$					
Period	$\ln Y_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	30.8581	2.9332	66.2085	0.0000	0.0000
2	19.9623	9.2269	70.0600	0.6884	0.0621
3	21.0160	8.5569	67.6155	2.6573	0.1540
4	21.8506	8.2150	63.6585	6.0563	0.2194
5	21.7135	7.9194	60.5925	9.5372	0.2372
6	21.2186	7.7447	58.7318	12.0737	0.2309
7	20.8085	7.6576	57.7142	13.5864	0.2330
8	20.5102	7.6291	57.2231	14.3807	0.2568
9	20.2795	7.6342	57.0140	14.7762	0.2959
10	20.1264	7.6576	56.8947	14.9846	0.3364
11	20.0733	7.6866	56.7584	15.1141	0.3673
12	20.1116	7.7128	56.5846	15.2065	0.3842
13	20.2066	7.7336	56.3979	15.2725	0.3892
14	20.3216	7.7512	56.2245	15.3141	0.3883
15	20.4332	7.7703	56.0723	15.3346	0.3893
Variance Decomposition of $\ln K_t$					
Period	$\ln Y_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	62.6933	0.0166	4.1105	33.1794	0.0000
2	72.3026	4.8829	2.4991	19.6773	0.6380
3	73.4825	5.7909	2.4558	16.3529	1.9177
4	71.3324	5.3533	5.1615	14.6910	3.4616
5	68.6926	5.1702	7.2288	13.9163	4.9919
6	67.0942	5.2640	7.6627	13.6219	6.3571
7	65.8951	5.7199	7.5599	13.4300	7.3949
8	63.8811	6.5912	8.4713	13.0984	7.9576
9	60.6058	7.8249	10.9313	12.6151	8.0225

10	56.5491	9.2264	14.3469	12.1608	7.7167
11	52.4604	10.5752	17.8093	11.9288	7.2263
12	48.8633	11.7153	20.7124	11.9991	6.7098
13	45.9703	12.5816	22.8473	12.3343	6.2663
14	43.7928	13.1755	24.2518	12.8365	5.9431
15	42.2509	13.5355	25.0614	13.4006	5.7513
Variance Decomposition of $\ln L_t$					
Period	$\ln Y_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	39.6111	9.0002	0.8222	1.6747	48.8915
2	45.9927	12.7837	0.6860	1.0804	39.4570
3	43.7693	19.2535	0.4962	0.3849	36.0959
4	38.4629	24.8713	2.3519	0.6440	33.6697
5	32.7736	29.1084	6.0023	1.5075	30.6080
6	27.5070	32.0679	10.9562	2.7241	26.7446
7	23.1173	33.8244	16.3734	4.0934	22.5913
8	19.7342	34.6336	21.4821	5.4872	18.6627
9	17.2769	34.8035	25.8223	6.8444	15.2527
10	15.5749	34.5943	29.2429	8.1424	12.4452
11	14.4512	34.1866	31.7834	9.37461	10.2039
12	13.7577	33.6921	33.5671	10.5373	8.4455
13	13.3815	33.1757	34.7362	11.6266	7.0798
14	13.2401	32.6736	35.4224	12.6379	6.0258
15	13.2739	32.2055	35.7378	13.5664	5.2162

The generalized impulse response function shows responsiveness of the regressors adds to shocks to each series within the vector autoregressive (VAR) model. Figure-3 plots the results of the impulse response function. The results indicate that energy consumption responds strongly to a unit standard deviation shock in financial development; and is true of financial development to energy consumption which suggests bidirectional causality. However, the relation is strong from financial development to energy consumption. The response of energy consumption from shocks in economic growth and labor is also strong and positive. Between economic growth and labor, causality runs from the former to the latter. Financial development responds positively to shocks in economic growth, but the response is weaker when it comes from a unit standard error random shock in labor.

Figure-3: Impulse Response Function (IRF)



The response of economic growth from a unit standard error shock to financial development is negative but insignificant. However, economic growth responds positively and significantly from a unit standard error random shock to financial development. The results lend support to the idea that financial development Granger causes economic growth. Finally, capital stock also positively responds to unit standard error random shocks in financial development and economic growth. Barring a few exceptions, results of impulse response function are very similar to those found from variance decomposition methods.

4. Concluding Remarks

This paper investigated the causal relationship between electricity consumption and economic growth by using the ARDL bounds testing to cointegration and vector error-correction models in Turkey. The study reconsiders the relationship between electricity consumption and economic growth by incorporating financial development, capital and labour force as important factors of production using augmented production function in Turkey for the period of 1971-2009.

We found long run relationship between electricity consumption, economic growth, financial development, capital and labour force. Further, results indicated that electricity consumption, financial development, capital and labor force have positive effect on economic growth. The VECM granger causality analysis shows feedback effect between electricity consumption, financial development, capital, labor force and economic growth in case of Turkey. This implies that high electricity consumption tends to have high economic growth and vice versa while financial development also plays an important role to stimulate energy demand directly by providing easy access to financial resources to individuals and indirectly by boosting economic growth through raising capital formation in the country.

The main finding from this study is that there is evidence of bidirectional causality which indicates that there is mutual interdependence between energy and economic growth in Turkey. The following are some of reasons that can account for these results: First, the changes in life-styles and the improved living standards of the people in Turkey. Second, economic growth Granger causes expansion in the commercial and industrial sectors, and electricity consumption is a basic input in these activities. Third, electrification has been proceeding quickly in both the household/commercial sector and the industrial sector in Turkey. The use of electrical appliances, such as televisions, refrigerators, washing machines, and air conditioners, has increased rapidly. The results from this study support the view that energy is a limiting factor to economic growth. Therefore a policy to increase investment in the energy sector such as electricity supply is likely to stimulate economic growth in Turkey.

References

Acaravci, A., (2010). Structural Breaks, Electricity Consumption and Economic Growth: Evidence from Turkey. Journal for Economic Forecasting, 2/2010, 140-154.

Acaravci, A., Ozturk, I. (2012). Electricity Consumption and Economic Growth Nexus: A Multivariate Analysis for Turkey. Amfiteatru Economic, 14(31), 246-257.

Altinay, G. and Karagol, E., (2005), "Electricity consumption and economic growth: evidence from Turkey", Energy Economics, 27, 849–856.

Bahmani-Oskooee. M., A. M. Nasir., (2004). ARDL approach to test the productivity bias hypothesis. Review of Development Economics 8, 483-488.

Bannerjee, A., J. Dolado., R. Mestre., (1998). Error-correction mechanism tests for cointegration in single equation framework. Journal of Time Series Analysis 19, 267-83.

Baum, C.F., (2004). A review of Stata 8.1 and its time series capabilities. International Journal of Forecasting 20, 151-161.

Clemente, J., Antonio, M., Marcelo, R., (1998). Testing for a unit root in variables with a double change in the mean. Economics Letters 59, 175-182.

Dickey, D., Fuller, W.A. (1979). Distribution of the estimates for autoregressive time series with unit root. Journal of the American Statistical Association 74, 427-431.

Elliot, G., Rothenberg, T.J., Stock, J.H., (1996). Efficient tests for an autoregressive unit root, Econometrica 64, 813-836.

ESMAP, (2009), Energy Sector Management Assistance Program 2009 Annual Report. Available at: http://www.esmap.org/esmap/sites/esmap.org/files/FINAL%20_ESMAP_AR09.pdf

Goldsmith, R. (1969). Financial Structure and Development. A Handbook, Yale University Press, 1969.

Granger, C.W.J., (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. Econometrica 37, 424-438.

Halicioglu, F., (2007), "Residential electricity demand dynamics in Turkey", Energy Economics 29, 199–210.

King, R.G. and Levine, R. (1993). Finance and Growth: Schumpeter Might be Right. The Quarterly Journal of Economics. 108 (3), 717-737.

Kraft, J. and Kraft, A., (1978), "On the relationship between energy and GNP",Journal of Energy and Development, 3, 401– 403.

Lütkepohl, H., (2006). Structural vector autoregressive analysis for cointegrated variables, AStA Advances in Statistical Analysis 90, 75-88.

Murray, D.A., Nan, G.D. (1996), "A definition of the gross domestic product-electrification interrelationship", Journal of Energy and Development, 19, 275–283.

Narayan P.K. and Prasad, A., (2008), "Electricity consumption-real GDP causality nexus: evidence from a bootstrapped causality test for 30 OECD countries", Energy Policy, 36, 910–918.

Narayan, P.K., (2005). The saving and investment nexus for China: Evidence from cointegration tests, Applied Economics 17, 1979-1990.

Narayan, P.K., Narayan, S., (2005). Estimating income and price elasticities of imports for Fiji in a cointegration framework. Economic Modelling 22, 423–438.

Narayan, P.K., Smyth, R., (2006). Higher education, real income and real investments in China: evidence from Granger causality tests. Education Economics 14, 107–125.

Ng, S., Perron, P., (2001). Lag length selection and the construction of unit root test with good size and power. Econometrica 69, 1519-1554.

Oh, W., Lee, K., (2004) Causal relationship between energy consumption and GDP: the case of Korea 1970–1999. *Energy Economics* **26**(1), pp: 51-59.

Ozturk, I., (2010), "A literature survey on energy–growth nexus", Energy Policy, 38, 340-349.

Payne, J.E., (2010), "A survey of the electricity consumption-growth literature", Applied Energy, 87(3), 723-731.

Pesaran, M.H., Shin, Y., Smith, R., (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics 16, 289-326.

Rajan, R. G. and Zingales, L. (1998). Financial Dependence and Growth. American Economic Review. 88 (3), 559-586.

Rajan, R. and Zingales, I., (2003). The Great Reversal: The Politics of Financial Development in the 20th Century, Journal of Financial Economics, 69(), 5-50.

Shahbaz, M., Islam, F., Aamir, N., (2012). Is devaluation contractionary? Empirical evidence for Pakistan. Economic Change and Restructuring. DOI 10.1007/s10644-011-9119-7.

Shahbaz, M., Lean, H.H., (2012). Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. Energy Policy 40, 473-479.

Shahbaz, M., Tang, C. F., Shabbir, M. S., (2011). Electricity consumption and economic growth nexus in Portugal using cointegration and causality approaches. Energy Policy 39, 3529-3536.

Shan, J., (2005). Does Financial Development 'Lead' Economic Growth? a vector auto-regression appraisal. Applied Economics 37, 1353-1367.

Soytas, U. and Sari R., (2007) "The relationship between energy and production: evidence from Turkish manufacturing industry", Energy Economics, 29, 1151–1165.

Wolde-Rufael, Y., (2009). The defence spending and external debt nexus in Ethiopia. Defence and Peace Economics 20, 423-436.

Wurgler, J. (2000). Financial Markets and the Allocation of Capital. Journal of Financial Economics. 58 (1-2), 187-214.

Zivot, E., Andrews, D., (1992). Further evidence of great crash, the oil price shock and unit root hypothesis. Journal of Business and Economic Statistics 10, 251-270.